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## TELEGRAPHIC INVENTION AND THE POST OFFICE.

THERE has been a decided tendency of late in certain scientific circles to depreciate the expositor and to glorify the discoverer. We do not think with that tongue-tied band, who, feeling that they lack the graces of diction and the power of verbal illustration, and envious of the reputation which these faculties procure their fortunate possessors, seize every opportunity of shearing the latter of their bright but ephemeral fame. We would honour the successful lecturer as well as the inventor, the preacher as well as the apostle, the bard as well as the warrior. We would give him due credit for his gift, his study, and his art; although at the same time we would know how to rank the endowments of the originator as the higher and more valuable of the two. Both kinds of ability come, however, by nature, and both are necessary. In every well-appointed profession there is a place for the speaker and the writer; and so is there in elegraphy. Mr. W. H. Preece would, we are sure, be named by a large majority as the mouthpiece of the electrical body in England. It is easy to decry expositors' powers, but it is very difficult to rival them, and we know of no member of the profession who rivals those of Mr. Preece. Our writer has not yet appeared, but in the meantime, let us not undervalue our spokesman.

The recent utterances of Mr. Preece at the Dublin meeting of the British Association* induce us to believe that he is not quite so happy with the pen as he is with the voice. The paper which he read before the Mechanical Section of that body is neither lucid in arrangement nor felicitous in style. Short and brilliant periods are little suited to express all the shades of accuracy, and scientific truth is ill at ease in the frippery of an epigram. Mr. Preece, we think, would have done his own arguments as well as those of his opponents, more justice had he allowed himself greater scope in the lineal dimensions of his sentences. We are not aware that any one but Mr. Preece himself has unqualifiedly said that invention in telegraphy had entirely left the shores of England and flown to America; some high authorities have held that it languishes here, and because of the Postal Telegraph monopoly. Mr. Preece does not believe that it even languishes; on the contrary his paper was read to show that improvement in telegraphy has never before been more active in England than since the Government has managed the business.

Mr. Preece's paper is more a vindication of the energy and ability of the electrical department of the Government service than a disproof of the allegation that the latter checks invention. He is arraigned at the bar of professional opinion, and he feels called upon to clear the charges which have been made. It is a justification of himself and his colleagues—a loud blast of the ego-trumpet—he has given us; not a convincing disproof of the point in dispute, and which, whatever Mr. Preece may think to the contrary is seriously believed by the majority of English and also American telegraphic inventors, namely, that the Postal Telegraph monopoly, as at present organised, has a baneful influence on inventions.

Mr. Preece mentions a great many novelties which have been introduced into the service since the Government took it over, and points out the further development of lines which has taken place. Neither the development of lines, nor the advances in submarine telegraphy, have to do with the question. Cables are in the hands of private companies, and mileage of wires only speaks for the enterprise of the Government officials. As regards the novelties adopted, it is too evident that the most valuable of these, with the exception of one, the Wheatstone Automatic, are foreign inventions. Mr. Preece states that the sounder is supplanting the Morse, the type-printer, and the needle instrument, on our lines; but where does the sounder come from?—America. Siemen's direct ink writer, is it not from Germany? Leclanché's battery, and Clamond's thermo-pile, are they not from France? While Bain's chemical recorder, Stearn's duplex, Edison's quadruplex, Gray's multiplex—have they not come from America also? It is no doubt true, as Mr. Preece says, that these systems have only been revived and perfected in America; but why is it that they have not been revived in England? Why have they lain neglected here, until they were resuscitated for us by the more vigorous invention across the Atlantic? Why has it been left for Mr. Elisha Gray, of Chicago, to realise in practice the harmonic telegraph patented by Varley, in 1870, in England? It is true that some minor improvements and inventions have been made by English inventors of late, especially by those in some way or other connected with the Post Office; but, excepting Wheatstone's Automatic, we have no first-rate novelty to show. For the sounder, the duplex, quadruplex, and telephone received from America, what electric apparatus have we given her?—"on some lines they have introduced automatic tele-

* See TELEGRAPHIC JOURNAL, September 1st, 1878.

graphy, as modified by Messrs. Little and Edison," and they are trying our batteries—that is all. Mr. Preece has only disparagement for the principal apparatus in use in France; and evidently rates the much lauded Wheatstone Automatic as far superior to those in point of expediency; but for all that, nearly 100 words per minute can be printed off by the Baudot-Hughes apparatus, and this without the expense of highly skilled operators, and copying clerks. When it is remembered that this system can be duplexed, if need be, it will perhaps be admitted that the French are little behind us, if not ahead, in fast-speed telegraphy.

We have no intention of criticising at length the table of patent statistics which Mr. Preece presents us with, although we have more than a suspicion that some American patents have been inadvertently included in his numbers. We shall just point out, however, that column 3, which gives the numbers of patents referring to the manufacture of telegraph material, during the last sixteen years, shows a notable falling off during the last six; and we shall supplement Mr. Preece's table with the additional information that during the eight years preceding 1862 (the first period given by him) the average of patents yearly taken out was about 70 as compared with 48 during the following eight years, and 52 during the last eight. From 1835 to 1842 only six telegraphic patents were taken out; from 1842 to 1852 fifty were taken out; in 1852 twelve were taken out; in 1854, thirty-three; in 1857, fifty; in 1858 (the year of the first Atlantic), a hundred and eight; from 1858 to 1862, over a hundred telegraphic patents were taken out yearly; in 1862 (the year which begins Mr. Preece's table) they fell to fifty-one, and have kept about the same number since. Another point worth stating is, that while the number of English telegraph patents taken out yearly is now for some reason stationary, the number of American ones patented in England is on the increase, even although American inventors are not at all sanguine of their adoption in England. We do not doubt that the American patent registry would show an ever increasing number of telegraph patents yearly. We hardly need to remind our readers, however, that the mere number of patents taken out is no very weighty argument against the thesis that successful telegraphic invention is suffering in England just now. It is not the number of patents taken out during given periods that should be compared, but rather the proportion of practical results they have yielded. It is the inventor's peculiar complaint that his patents, when taken out, are allowed to perish in neglect.

As we have before said, it is not the individual management and enterprise of the Government service which is at fault. As we believe that the Postal Telegraph system is a benefit to the community at large, so we believe that its officers are to be commended for their zeal and practical ability; but it is not a question of men; it is a question of system. We feel sure that Mr. W. H. Preece, and his colleagues, will frankly receive inventions and have them tried, when requested to do so. But the merits of an invention should be left to the decisions of no single individual; for all men have their peculiar biasses, opinions, and humours, which, willy nilly, sway their judgments. Inventors, as Mr. Preece says, may be a jealous and troublesome race, but that is all the more reason that the causes for their mistrust should be removed. We confess to no little astonishment when Mr. Preece tells us, in one of his too terse sentences, that "practical inventions rarely emanate from without." Was not Arkwright a barber, and Watt an optician? To go no further than the names of inventors furnished by Mr. Preece himself, was not Bain a clockmaker, Morse an artist, Wheatstone a professor of acoustics, Thomson a professor of physics? No single name of the list of English inventors given by Mr. Preece belongs to the Postal Telegraph service. The officers of that service, no doubt, effect some small improvements on apparatus submitted to their care; but it is not to them that we must look for inventions. Mr. Preece must know that inventive genius is a spontaneous article, and cannot be furnished on demand by any corps of officials, however well trained; it is from the whole country that the indigenous supply must be drawn. The total of inventive ability produced by the nation yearly is, perhaps in general, a constant quantity; but the sphere to which it devotes itself is greatly influenced by external circumstances. If the conditions for telegraphic invention are ungenial it will simply turn itself to other fields. In the discussion following Mr. Preece's paper, Prof. Graham Bell strikingly showed how little encouragement was to be got by an uninfluential inventor under the existing Postal Telegraph system in England. In 1874, in desiring to submit his multiple telegraph to the department, he was informed that it would be tried *at his own expense*; and, if successful, *the question of remuneration would be left to the Postmaster-General*. This reply caused him to bring forward his invention in America, and the outcome was the speaking telephone.

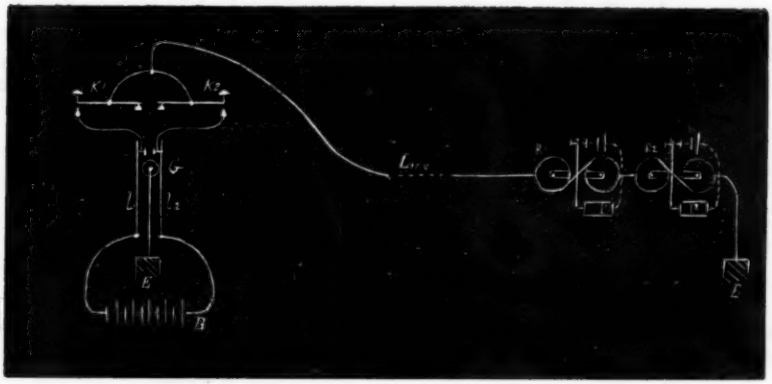
These remarks of Prof. Bell, and the letter of Mr. Herring in the *Journal of the Society of Arts* for August 30th, reveal a state of things which, independently of the general proposition in dispute, call for a reformation. As we have said before, it is the existing system which is defective, if indeed there be any system at all, and a more satisfactory one must be substituted for it as speedily as possible. In France, and in other Continental countries where a Government telegraph service exists, there is a special commission of eminent electricians, of diverse views and experience, appointed by Government to sit at certain periods to consider all telegraphic inventions brought before them. Any of these which are considered meritorious are forthwith fostered; a sum being granted to the inventor to develope it, and other facilities afforded him for experimenting. If successful, it is then recommended by them to the Government officials for adoption into the service, and they also fix the amount of remuneration to be paid for it. It is to the beneficent working of this system that the French Telegraphic Annexe at the Paris Exhibition this year owes so many novelties, and puts the British section to the blush; nearly every electrical mechanician of note in Paris, and these are to be numbered literally by the score, having some novelty to show which the French Government has aided him to produce. How different is the tale in England!

These remarks have led us to an unusual length; but the subject is one of crying importance. We cannot conclude without urging on the Postmaster

General to take steps to introduce the French system, or one analogous to it, in England. A mere reference to individual advisers, such as was resorted to in the case of Mr. Herring, only shows that the want of a commission was felt, but not supplied. We will rest now in the hope that a competent commission will ere long be appointed; for without it the fault of the present system will inevitably stifle telegraphic invention.

## SIEUR'S DOUBLE TRANSMISSION TELEGRAPH SYSTEM.

THE principle of this system is shown by the figure $l_1$, and $l_2$, are spring contact levers connected to the poles of a battery B. These levers normally make contact with stops connected with the front contacts of keys $K_1$ and $K_2$. A cam C, connected to earth, is kept in very rapid rotation by means of clockwork, and the levers, by this means, are caused to oscillate alternately, with extreme rapidity, to and fro from their contact stops. The result of this arrangement is, that if key $K_1$ is depressed, a rapid succession of currents of one sign are caused to pass out to line; and if $K_2$ be depressed, a rapid succession of currents of the opposite sign pass to line; whilst if both keys be depressed, then both positive and negative currents succeeding one another with great speed, will flow.



The line wire leads to a pair of polarised relays $R_1$ and $R_2$ so connected up, that one responds to positive and the other to negative currents, each operating a local battery connected with receiving instruments $I_1$, $I_2$.

As the positive and negative currents alternate, the one set of signals does not interfere with the other set, and as the succession of impulses of either sign is rapid, the effect on each receiver does not practically differ from that produced by a continued current of the sign for which the receiver is adapted.

Several modifications of the arrangement just described are proposed by M. Sieur; thus, the relay tongues may normally be held over to their insulating stops by the succession of currents, the depression of the keys being made to cut off the currents of either sign. The receiving apparatus also, may be a single relay provided with two tongues oppositely polarised. Again, two batteries may be employed to give the opposite currents, the cam in this case putting earth on to each battery alternately; indeed, the modifications of which the principle is susceptible are very numerous, as must be evident.

By duplexing the arrangement in the ordinary way, quadruplex working is obtained.

We understand that M. Sieur's system is in successful operation on the Continent.

The apparatus is shown in the Telegraphic Annexe of the Paris Exhibition.

## A NEW GALVANOMETER SHUNT BOX.

By H. R. KEMPE.

WHEN a galvanometer has a shunt of any particular marked value inserted between its terminals, the reduction in the deflection will not be proportional to that marked value; thus, if a galvanometer be joined up in circuit with a battery, and a certain deflection be produced, then the insertion of the $\frac{1}{10}$th shunt will not reduce the deflection by $\frac{1}{10}$th, but by a larger fractional value. This arises from the fact that the total resistance in the battery circuit is reduced by the introduction of the shunt. In order to effect the reduction of the deflection to the marked value, it is necessary to introduce with the shunt a "compensating" resistance which shall cause the total resistance to remain unaltered. If galvanometers provided with shunts were also provided with such "compensating" resistances, much calculation would be avoided in making experiments. In the present article the author proposes to show how these compensating resistances can be attached to galvanometers, and how their values may be calculated.

Let S, $S_1$, $S_2$, be shunts which can be connected to the galvanometer by inserting plugs at A, B, or C.

Let $r_1$, $r_2$, $r_p$ be compensating resistances, and let

$$r_1 + r_2 + r_1 = R_1 \qquad (1)$$
$$r_2 + r_1 = R_2 \qquad (2)$$

Now, what we have to do, is to find what values of S, $S_1$, $S_2$, and $r_1$, $r_2$, $r_1$, are necessary, so that when a plug is introduced either at A, B, or C, the resistance between D and E shall always be the same, whilst the necessary portion of the currrent is shunted off from the galvanometer.

Fig. 1.

Let us first consider the shunt S and the compensating resistance which in this case, will be $R_1$.

When the shunts and compensating resistances are not in use, the resistance in circuit is of course G, and this value must always be preserved between D and E.

Let the value of the shunt S required be $\frac{1}{n}$th, then we know that the resistance of S necessary to give this, is

$$S = \frac{G}{n-1}$$

By the insertion of this shunt the resistance between the terminals of the galvanometer is reduced to

$$\frac{G\,S}{G+S} = \frac{G\ \frac{G}{n-1}}{G+\frac{G}{n-1}} = \frac{\frac{G}{n-1}}{1+\frac{1}{n-1}} = \frac{G}{n} \qquad (3)$$

consequently the resistance which should be given to $R_1$ to bring the resistance between D and E up to G, will be

$$R_1 = G - \frac{G}{n} = G\,\frac{n-1}{n} \qquad (4)$$

We next have to consider what value to give to $S_1$ and $R_2$.

Let it be required to reduce the deflection by $\frac{1}{n_1}$th, then the value to be given to $S_1$ will be

$$S_1 = \frac{G + r_1}{n_1 - 1}$$

to solve which, we must know the value of $r_1$.

Now, the combined resistance of the shunt and $G + r_1$ we can see from (3) is

$$\frac{G + r_1}{n_1}$$

herefore the value required to be given to $R_2$, in order to preserve the resistance between D and E, equal to G, when $S_2$ is connected, will be

$$R_2 = G - \frac{G + r_1}{n_1}$$

or

$$R_2 + \frac{r_1}{n_1} = G\,\frac{n_1 - 1}{n_1} \qquad (5)$$

but from (1), (2), and (4)

$$R_2 + r_1 = R_1 = G\,\frac{n-1}{n} \qquad (6)$$

therefore, substracting (6) from (5), we have

$$\frac{r_1}{n_1} - r_1 = G\left(\frac{n_1 - 1}{n} - \frac{n-1}{n}\right) = G\,\frac{n_1 - n}{n\,n_1}$$

that is

$$r_1\,\frac{1 - n_1}{n_1} = G\,\frac{n_1 - n}{n\,n_1}$$

or

$$r_1 = G\,\frac{(n - n_1)}{n\,(n_1 - 1)}$$

consequently the value of $S_2$ will be

$$S_1 = G\,\frac{1 + \frac{n - n_1}{n\,(n_1 - 1)}}{n_1 - 1} = G\,\frac{(n-1)\,n_1}{n\,(n_1 - 1)^2}$$

In like manner it could be shown that the resistance necessary to give $S_2$ and $r_1 + r_2$ to reduce the deflection to its $\frac{1}{n_2}$ th part would be

$$S_2 = G\,\frac{(n-1)\,n_2}{n\,(n_2 - 1)^2}$$

and

$$r_1 + r_2 = G\,\frac{n - n_2}{n\,(n_2 - 1)}$$

or

$$r_2 = G\,\frac{n - n_2}{n\,(n_2 - 1)} - r_1$$

Finally we have from (1) and (4)

$$r_1 = R_1 - (r_1 + r_2) = G\,\frac{n-1}{n} - (r_1 + r_2)$$

To summarise then,

$$S = G\,\frac{1}{n-1}$$

$$S_1 = G\,\frac{(n-1)\,n_1}{n\,(n_1 - 1)^2}$$

$$S_2 = G\,\frac{(n-1)\,n_2}{n\,(n_2 - 1)^2}$$

and for any other shunt $S_p$

$$S_p = G\,\frac{(n-1)\,n_p}{n\,(n_p - 1)^2}$$

The compensating resistances *between* the shunts will be

$$r_1 = G\,\frac{n - n_1}{n\,(n_1 - 1)}$$

$$r_2 = G\,\frac{n - n_2}{n\,(n_2 - 1)} - r_1$$

and also we have

$$r_1 + r_2 + \ldots + r_p = G\,\frac{n - n_p}{n_p - 1}$$

or

$$r_p = G\,\frac{n - n_p}{n\,(n_p - 1)} - (r_1 + r_2 + \ldots + r_{p-1})$$

The *last* resistance $r_1$ beyond the last shunt will be

$$r_1 = G\,\frac{n-1}{n} - (r_1 + r_2 + \ldots + r_p)$$

*For example.*

It was required to provide a galvanometer with $\frac{1}{10}$th, $\frac{1}{100}$th, and $\frac{1}{1000}$th shunts, and with correspond-

ing compensating resistances arranged according to fig. 1. What should be their value?

We have

$$n = 1000,\ n_1 = 100,\ n_2 = 10$$

therefore

$$n - 1 = 999,\ n_1 - 1 = 99,\ n_2 - 1 = 9$$

Then

$$S = G\,\frac{1}{999} = G \times \cdot001001$$

$$S_1 = G\,\frac{999 \times 100}{1000 \times 99 \times 99} = G \times \cdot010193$$

$$S_2 = G\,\frac{999 \times 10}{1000 \times 9 \times 9} = G \times \cdot12333$$

and

$$r_1 = G\,\frac{1000 - 100}{1000 \times 99} = G \times \cdot0090909$$

$$r_1 + r_2 = G\,\frac{1000 - 10}{1000 \times 9} = G \times \cdot11$$

from which

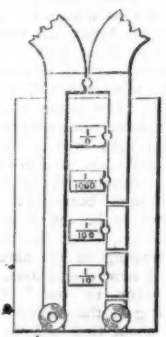
$$r_2 = G\,(\cdot11 - \cdot0090909) = G \times \cdot1009091$$

also

$$r = G\,\frac{999}{1000} - (r_1 + r_2) = G\,(\cdot999 - \cdot11) = G \times \cdot889$$

If the resistance of the galvanometer, for which these shunts and compensating resistances are to be provided, is 5,000 ohms, then

$S = 5000 \times \cdot001001 = 5\cdot006$ ohms.
$S_1 = 5000 \times \cdot010193 = 50\cdot964$ ,,
$S_2 = 5000 \times \cdot12333 = 616\cdot667$ ,,
$r_1 = 5000 \times \cdot0090909 = 45\cdot455$ ,,
$r_2 = 5000 \times \cdot1009091 = 504\cdot545$ ,,
$r_3 = 5000 \times \cdot889 = 4445\cdot000$ ,,




*½ real size*

Fig. 2

Fig. 2 shows how an ordinary Thomson galvanometer shunt box would be arranged with compensating resistances.

The plug hole marked $\frac{1}{0}$, when it has a plug inserted in it, connects the top left hand brass block to the bottom left hand block, and so leaves the galvanometer connected to the terminals of the shunt box without any additional resistance in its circuit. The connection between the brass blocks is shown by the dotted line in Fig. 1.

## THE BRITISH ASSOCIATION.

### ADDRESS OF WILLIAM SPOTTISWOODE, Esq., M.A., D.C.L., L.L.D., F.R.S., F.R.A.S., F.R.G.S., PRESIDENT.

*(Concluded from page 356.)*

It has often been asked whether modern research in the field of Pure Mathematics has not so completely outstripped its physical applications as to be practically useless; whether the analyst and geometer might not now, and for a long time to come, fairly say, "hic artem remumque repono," and turn his attention to Mechanics and to Physics. That the Pure has outstripped the Applied is largely true; but that the former is on that account useless is far from true. Its utility often crops up at unexpected points; witness the aids to classification of physical quantities, furnished by the ideas (of Scalar and Vector) involved in the Calculus of Quaternions; or the advantages which have accrued to Physical Astronomy from Lagrange's Equations, and from Hamilton's Principle of Varying Action; on the value of Complex Quantities, and the properties of general Integrals, and of general theorems on integration for the Theories of Electricity and Magnetism. The utility of such researches can in no case be discounted, or even imagined beforehand; who, for instance, would have supposed that the Calculus of Forms or the Theory of Substitutions would have thrown much light upon ordinary equations; or that Abelian Functions and Hyperelliptic Transcendents would have told us anything about the properties of curves; or that the Calculus of Operations would have helped us in any way towards the figure of the Earth? But upon such technical points I must not now dwell. If, however, as I hope, it has been sufficiently shown that any of these more extended ideas enable us to combine together, and to deal with as one, properties and processes which from the ordinary point of view present marked distinctions, then they will have justified their own existence; and in using them we shall not have been walking in a vain shadow, nor disquieting our brains in vain.

These extensions of mathematical ideas would, however, be overwhelming, if they were not compensated by some simplifications in the processes actually employed. Of these aids to calculation I will mention only two, viz., symmetry of form, and mechanical appliances; or, say, Mathematics as a Fine Art, and Mathematics as a Handicraft. And first, as to symmetry of form. There are many passages of algebra in which long processes of calculation at the outset seem unavoidable. Results are often obtained in the first instance through a tangled maze of formulæ, where at best we can just make sure of our process step by step, without any general survey of the path which we have traversed, and still less of that which we have to pursue. But almost within our own generation a new method has been devised to clear this entanglement. More correctly speaking, the method is not new, for it is inherent in the process of algebra itself, and instances of it, unnoticed perhaps or disregarded, are to be found cropping up throughout nearly all mathematical treatises. By Lagrange, and to some extent also by Gauss, among the old writers, the method of which I am speaking was recognised as a principle; but besides these perhaps no others can be named until a period within our own recollection. The method consists in symmetry of expression. In algebraical formulæ combinations of the quantities entering therein occur and recur; and by a suitable choice of these quantities the various combinations may be rendered symmetrical, and reduced to a few well known types. This having been done, and one such combination having been calculated, the remainder, together with many of their results, can often be written down at once, without further

calculations, by simple permutations of the letters. Symmetrical expressions, moreover, save us much time and trouble in reading as in writing. Instead of wading laboriously through a series of expressions which, although successively dependent, bear no outward resemblance to one another, we may read off symmetrical formulæ, of almost any length, at a glance. A page of such formulæ becomes a picture: known forms are seen in definite groupings; their relative positions, or perspective, as it may be called, their very light and shadow, convey their meaning almost as much through the artistic faculty as through any conscious ratiocinative process. Few principles have been more suggestive of extended ideas or of new views and relations than that of which I am now speaking. In order to pass from questions concerning plane figures to those which appertain to space, from conditions having few degrees of freedom to others which have many—in a word, from more restricted to less restricted problems—we have in many cases merely to add lines and columns to our array of letters or symbols already formed, and then read off pictorially the extended theorems.

Next as to mechanical appliances. Mr. Babbage, when speaking of the difficulty of ensuring accuracy in the long numerical calculations of theoretical astronomy, remarked, that the science which in itself is the most accurate and certain of all had, through these difficulties, become inaccurate and uncertain in some of its results. And it was doubtless some such consideration as this, coupled with his dislike of employing skilled labour where unskilled would suffice, which led him to the invention of his calculating machines. The idea of substituting mechanical for intellectual power has not lain dormant; for besides the arithmetical machines whose name is legion (from Napier's Bones, Earl Stanhope's calculator, to Schultz and Thomas's machines now in actual use) an invention has lately been designed for even a more difficult task, Prof. James Thomson has in fact recently constructed a machine which, by means of the mere friction of a disc, a cylinder, and a ball, is capable of effecting a variety of the complicated calculations which occur in the highest application of mathematics to physical problems. By its aid it seems that an unskilled labourer may, in a given time, perform the work of ten skilled arithmeticians. The machine is applicable alike to the calculation of tidal, of magnetic, of meteorological, and perhaps also of all other periodic phenomena. It will solve differential equations of the second and perhaps of even higher orders. And through the same invention the problem of finding the free motions of any number of mutually attracting particles, unrestricted by any of the approximate suppositions required in the treatment of the Lunar and Planetary Theories, is reduced to the simple process of turning a handle.

When Faraday had completed the experimental part of a physical problem, and desired that it should thenceforward be treated mathematically, he used irreverently to say, "Hand it over to the calculators." But truth is ever stranger than fiction; and if he had lived until our day, he might with perfect propriety have said, "Hand it over to the machine."

Had time permitted, the foregoing topics would have led me to point out that the mathematician, although concerned only with abstractions, uses many of the same methods of research as are employed in other sciences, and in the arts, such as observation, experiment, induction, imagination. But this is the less necessary because the subject has been already handled very ably, although with greater brevity than might have been wished, by Professor Sylvester in his address to Section A at our meeting at Exeter.

In an exhaustive treatment of my subject there would still remain a question which in one sense lies at the bottom of all others, and which through almost all time has had an attraction for reflective minds, viz., what was the origin of mathematical ideas? Are they to be regarded as independent of, or dependent upon, experience? The question has been answered sometimes in one way and sometimes in another. But the absence of any satisfactory conclusion may after all be understood as implying that no answer is possible in the sense in which the question is put; or rather that there is no question at all in the matter, except as to the history of actual facts. And, even if we distinguish, as we certainly should, between the origin of ideas in the individual and their origin in a nation or mankind, we should still come to the same conclusion. If we take the case of the individual, all we can do is to give an account of our own experience; how we played with marbles and apples; how we learnt the multiplication table, fractions, and proportion; how we were afterwards amused to find that common things conformed to the rules of number; and later still how we came to see that the same laws applied to music and to mechanism, to astronomy, to chemistry, and to many other subjects. And then, on trying to analyse our own mental processes, we find that mathematical ideas have been imbibed in precisely the same way as all other ideas, viz., by learning, by experience, and by reflection. The apparent differences in the mode of first appending them and in their ultimate cogency arises from the difference of the ideas themselves, from the preponderance of quantitative over qualitative considerations in mathematics, from the notions of absolute equality and identity which they imply.

If we turn to the other question, How did the world at large acquire and improve its idea of number and of figures? How can we span the interval between the savage who counted only by the help of outward objects to whom 15 was "half the hands and both the feet," and Newton or Laplace? The answer is the history of mathematics and its successive developments, arithmetic, geometry, algebra, &c. The first and greatest step in all this was the transition from number in the concrete to number in the abstract. This was the beginning not only of mathematics but of all abstract thought. The reason and mode of it was the same as in the individual. There was the same general influx of evidence, the same unsought-for experimental proof, the same recognition of general laws running through all manner of purposes and relations of life. No wonder then if, under such circumstances, mathematics, like some other subjects and perhaps with better excuse, came after a time to be clothed with mysticism; nor that, even in modern times, they should have been placed upon an *à priori* basis, as in the philosophy of Kant. Number was so soon found to be a principal common to many branches of knowledge that it was readily assumed to be the key to all. It gave distinctness of expression, if not clearness of thought, to ideas which were floating in the untutored mind, and even suggested to it new conceptions. In "the one," "the all," "the many in one" (terms of purely arithmetic origin), it gave the earliest utterance to men's first crude notions about God and the world. In "the equal," "the solid," "the straight," and "the crooked," which still survive as figures of speech among ourselves, it supplied a vocabulary for the moral notions of mankind, and quickened them by giving them the power of expression. In this lies the great and enduring interest in the fragments which remain to us of the Pythagorean philosophy.

The consecutive processes of Mathematics led to the consecutive processes of Logic; but it was not until long after mankind had attained to abstract ideas that they attained to any clear notion of their connexion with one another. In process of time the leading ideas of Mathematics became the leading ideas of Logic. The "one" and the "many" passed into the "whole" and its "parts;" and thence into the "universal" and the "particular." The fallacies of Logic, such as the well-known puzzle of Achilles and the tortoise, partake of the nature of both

sciences. And perhaps the conception of the infinite and the infinitesimal, as well as of negation, may have been in early times transferred from Logic to Mathematics. But the connexion of our ideas of number is probably anterior to the connexion of any of our ideas. And as a matter of fact, geometry and arithmetic had already made considerable progress when Aristotle invented the syllogism.

General ideas there were, beside those of mathematics—true flashes of genius which saw that there must be general laws to which the universe conforms, but which saw them only by occasional glimpses, and through the distortion of imperfect knowledge; and although the only records of them now remaining are the inadequate representations of later writers, yet we must still remember that to the existence of such ideas is due not only the conception but even the possibility of Physical Science. But these general ideas were too wide in their grasp, and in early days at least were connected in their subject of application by links too shadowy, to be thoroughly apprehended by most minds; and so it came to pass that one form of such an idea was taken as its only form, one application of it as the idea itself; and philosophy, unable to maintain itself at the level of ideas, fell back upon the abstractions of sense, and by preference, upon those which were most ready to hand, namely, those of mathematics. Plato's ideas relapsed into a doctrine of numbers; mathematics into mysticism, into neo-Platonism, and the like. And so, through many long ages, through good report and evil report, mathematics have always held an unsought-for sway. It has happened to this science as to many other subjects, that its warmest adherents have not always been its best friends. Mathematics have often been brought into matters where their presence has been of doubtful utility. If they have given precision to literary style, that precision has sometimes been carried to excess, as in Spinoza and perhaps Descartes; if they have tended to clearness of expression in philosophy, that very clearness has sometimes given an appearance of finality not always true; if they have contributed to definition in theology, that definiteness has often been fictitious, and has been attained at the cost of spiritual meaning. And, coming to recent times, although we may admire the ingenuity displayed in the logical machines of Earl Stanhope and of Stanley Jevons, in the "Formal Logic" of De Morgan, and in the "Calculus" of Boole; although as mathematicians we may feel satisfaction that these feats (the possibility of which was *à priori*) have been actually accomplished; yet we must bear in mind that their application is really confined to cases where the subject-matter is perfectly uniform in character, and that beyond this range they are perfectly liable to encumber rather than to assist thought.

Not unconnected with this intimate association of ideas and their expression is the fact that, whichever may have been cause, whichever effect, or whether both may not in turn have acted as cause and effect, the culminating age of classic art was contemporaneous with the first great development of mathematical science. In an earlier part of this discourse I have alluded to the importance of mathematical precision recognised in the technique of art during the Cinquecento; and I have now time only to add that on looking still further back it would seem that sculpture and painting, architecture and music, nay even poetry itself, received a new, if not their first true, impulse at the period when geometric form appeared fresh chiselled by the hand of the mathematician, and when the first ideas of harmony and proportion rang joyously together in the morning tide of art.

Whether the views on which I have here insisted be in any way novel, or whether they be merely such as from habit or from inclination they are usually kept out of sight, matters little. But whichever be the case, they may still furnish a solvent of that rigid aversion which both Literature and Art are too often inclined to maintain towards Science of all kinds. It is a very old story that, to know one another better, to dwell upon similarities rather than upon diversities, are the first stages towards a better understanding between two parties; but in few cases has it a truer application that in that here discussed. To recognise the common growth of scientific and other instincts until the time of harvest is not only conducive to a rich crop, but it is also a matter of prudence, lest in trying to root up weeds from among the wheat, we should at the same time root up that which is as valuable as wheat. When Pascal's father had shut the door of his son's study to mathematics, and closeted him with Latin and Greek, he found on his return the walls were teeming with formulæ and figures, the more congenial product of the boy's mind. Fortunately for the boy, and fortunately also for Science, the mathematics were not torn up, but were suffered to grow together with other subjects. And all said and done, the lad was not the worse scholar or man of letters in the end. But, truth to tell, considering the severance which still subsists in education and during our early years between Literature and Science, we can hardly wonder if when thrown together in the afterwork of life they should meet as strangers; or if the severe garb, the curious implements, and the strange wares of the latter should seem little attractive when contrasted with the light companionship of the former. The day is yet young, and in the early dawn many things look weird and fantastic which in fuller light prove to be familiar and useful. The outcomings of Science, which at one time have been deemed to be but stumbling-blocks scattered in the way, may ultimately prove stepping stones which have been carefully laid to form a pathway over difficult places for the children of "sweetness and of light."

The instances on which we have dwelt are only a few out of many in which Mathematics may be found ruling and governing a variety of subjects. It is as the supreme result of all experience, the framework in which all the varied manifestations of nature have been set, that our science has laid claim to be the arbiter of all knowledge. She does not indeed contribute elements of fact, which must be sought elsewhere; but she sifts and regulates them: she proclaims the laws to which they must conform if those elements are to issue in precise results. From the data of a problem she can infallibly extract all possible consequences, whether they be those first sought, or others not anticipated; but she can introduce nothing which was not latent in the original statement. Mathematics cannot tell us whether there be or be not limits to time or space; but to her they are both of indefinite extent, and this in a sense which neither affirms or denies that they are either infinite or finite. Mathematics cannot tell us whether matter be continuous or discreet in its structure; but to her it is indifferent whether it be one or the other, and her conclusions are independent of either particular hypothesis. Mathematics can tell us nothing of the origin of matter, of its creation or its annihilation; she deals only with it in a state of existence; but within that state its modes of existence may vary from our most elementary conception to our most complex experience. Mathematics can tell us nothing beyond the problems which she specifically undertakes; she will carry them to their limit, but there she stops, and upon the great region beyond she is imperturbably silent.

Conterminous with space and coëval with time is the kingdom of Mathematics; within this range her dominion is supreme; otherwise than according to her order nothing can exist; in contradiction to her laws nothing takes place. On her mysterious scroll is to be found written for those who can read it that which has been, that which is, and that which is to come. Everything material which is the subject of knowledge

has number, order, or position; and these are her first outlines for a sketch of the universe. If our more feeble hands cannot follow out the details, still her part has been drawn with an unerring pen, and her work cannot be gainsayed. So wide is the range of mathematical science, so indefinitely may it extend beyond our actual powers of manipulation, that at some moments we are inclined to fall down with even more than reverence before her majestic presence. But so strictly limited are her promises and powers, about so much that we might wish to know does she offer no information whatever, that at other moments we are fain to call her results but a vain thing, and to reject them as a stone when we had asked for bread. If one aspect of the subject encourages our hopes, so does the other tend to chasten our desires; and he is perhaps the wisest, and in the long run the happiest among his fellows, who has learnt not only this science, but also the larger lesson which it indirectly teaches, namely, to temper our aspirations to that which is possible, to moderate our desires to that which is attainable, to restrict our hopes to that of which accomplishment, if not immediately practicable, is at least distinctly within the range of conception. That which is at present beyond our ken may, at some period and in some manner as yet unknown to us, fall within our grasp; but our science teaches us, while ever yearning with Goethe for "Light, more light," to concentrate our attention upon that of which our powers are capable, and contentedly to leave for future experience the solution of problems to which we can at present say neither yea nor nay.

It is within the region thus indicated that knowledge in the true sense of the word is to be sought. Other modes of influence there are in society and in individual life, other forms of energy beside that of intellect. There is the potential energy of sympathy, the actual energy of work; there are the vicissitudes of life, the diversity of circumstance, health, and disease, and all the perplexing issues, whether for good or for evil, of impulse and of passion. But although the book of life cannot at present be read by the light of Science alone nor the wayfarers be satisfied by the few loaves of knowledge now in our hands; yet it would be difficult to overstate the almost miraculous increase which may be produced by a liberal distribution of what we already have, and by a restriction of our cravings within the limits of possibility.

In proportion as method is better than impulse, deliberate purpose than erratic action, the clear glow of sunshine than irregular reflexion, and definite utterances than an uncertain sound; in proportion as knowledge is better than surmise, proof than opinion; in that proportion will the mathematician value a discrimination between the certain and the uncertain, and a just estimate of the issues which depend upon one motive power or the other. While on the one hand he accords to his neighbours full liberty to regard the unbeknown in whatever way they are led by the noblest powers that they possess; so on the other he claims an equal right to draw a clear line of demarcation between that which is a matter of knowledge, and that which is at all events something else, and to treat the one category as fairly claiming our assent, the other as open to further evidence. And yet, when he sees around him those whose aspirations are so fair, whose impulses so strong, whose receptive faculties so sensitive, as to give objective reality to what is often but a reflex from themselves, or a projected image of their own experience, he will be willing to admit that there are influences which he cannot as yet either fathom or measure, but whose operation he must recognise among the facts of our existence.

## THE MICROPHONE.

### ON A NEW FORM OF RECEIVING INSTRUMENT FOR THE MICROPHONE.

By W. J. MILLAR, C.E., Secretary of the Institution of Engineers and Shipbuilders, in Scotland.

Read before Section A of the British Association.

THE object of the present paper is to describe a new form of receiving instrument for the microphone, as devised by the author.

In a paper communicated to the Physical Society of London, on March 16, 1878, the author gave a detailed account of some experiments which he had been carrying out upon the transmission of sound by various substances without the aid of electricity or magnetism.

Some very curious results were obtained from these experiments, wires being extended in various ways from point to point through buildings, and carried to distances in the open air. These wires were in some cases laid upon the carpets from room to room, and the doors shut upon them. Yet in all these cases communications could be carried on between persons situated at each end of the wire.

The transmitting and receiving parts were simple discs set in deep or shallow rims—as the case might be—the connecting wire being fastened to the centre of each disc. The discs found most suitable were of pasteboard.

In all such transmission the vocal or other sounds were taken up from the air by the disc of the mouthpiece, and changed into vibratory movements of the materials in connexion; finally arriving at the receiving disc of the earpiece, and given out again to the air as sonorous vibrations. In studying the various phenomena presented, it occurred to the author that, as the particles of the wire and connexions must be in a state of rapidly varying strain, that if an electric current were circulating through the wire at the time of transmission of sound, the strains due to the vibrations of the particles of the wire might act upon the current so as to be reproduced by suitable means at the other end of the circuit.

The announcement of Professor Hughes' discovery of the microphone at once showed that the various states of strain in a substance or substances in contact, was sufficient to cause corresponding changes in the flow of an electric current passing at the time through the wire, whereby vocal sounds could be transmitted.

After some experiments with the microphone, the author placed a small pocket compass, having a number of turns of the conducting wire round it, and noted the motion of the needle as sounds were emitted close to the transmitter (the transmitter used was a piece of pointed carbon resting upon a piece of coke); variations in the motion of the needle were then observed, and differing for different sounds.

A small sewing needle was magnetised and suspended in a light pasteboard frame. A few turns of fine wire were passed along it so as to form a light galvanometer; distinct taps were then heard as the current was interrupted.

After some experimenting in this manner, it occurred to the author that if the needle were fixed, then, instead of moving when the current passed, it would be thrown into a state of strain, and as conditions of varying strain in the bodies experimented on in the experiments formerly referred to had been found to produce sound, then, when such state of strain was induced in the magnetic needle, sound would be the result, and that the flow of the current, as modified by the microphone transmitter, would reproduce through this straining action of the needle receiver the sounds emitted at the transmitter.

In order to test this a few yards of No. 30 covered copper wire were passed lengthwise along a small bar magnet

3 in. long, when it was found that upon breaking contact faint sounds were heard when the magnet was held to the ear. By placing the magnet against the lid of a pasteboard box the sounds were much intensified.

Thinking that a stronger magnet would give better results, the author took a horseshoe magnet 6 in. long, and laid along one half of it from two to three yards of the same wire; a much louder sound was then heard, and by placing the lid of a tin box on the flat side of the ends of the magnet an excellent receiving instrument was obtained. With this, singing, whistling, speaking, and violin music were readily rendered audible.

The battery consisted of a single Leclanché cell, the transmitter being two pieces of carbon pencil attached to wires in circuit, and slightly touching each other at their points. One of these wires rested upon an upright pasteboard box, into which the sounds were directed.

In making some further experiments, the small bar magnet was found quite suitable, and the receiver, as now exhibited to the meeting, has acted well, although of such small dimensions. The magnet is 3 in. long, $\frac{5}{16}$ in. broad, and fully $\frac{3}{16}$ in. thick, and has about six yards of No. 30 covered wire passed along its longer axis; it is placed in a shallow pasteboard box with two tin plates above and below it; the lid being placed on constitutes the whole an easily portable pocket instrument.

With a comparitively simple arrangement and with a single Leclanché cell, speaking, whistling, breathing, &c., are readily transmitted.

The author has been unable, from other duties, to follow up these experiments so far as to show what sizes and arrangements are best, but from the very satisfactory results got from the arrangements tried, he believes that there is a very interesting field of inquiry in the direction indicated, which he believes warrants him in bringing the subject before the members of the British Association.

Since the foregoing was written, the author has found that sounds can be obtained without a magnet, the receiver being simply a piece of tin around which a few yards of covered copper wire is wound; the various microphone phenomena can be exhibited with this simple receiver; the sounds, however, are very much reduced in loudness.

## ON UNILATERAL CONDUCTIVITY IN TOURMALINE CRYSTALS.

By Professor SILVANUS P. THOMPSON, and Dr. OLIVER J. LODGE.

Abstract of Paper read before Section A, British Association, August 20th, 1878.

THE authors regarded the phenomena of pyroelectricity as exhibited by the tourmaline and other crystals as of the utmost significance in the theory of the relation of electricity to the particles of matter. Dr. Lodge had read a paper at the British Association meeting at Glasgow on a mechanical model illustrating the flow of an electric current through a circuit. The considerations therein advanced had independently led the authors to conclude that the phenomena of pyroelectricity could be explained if it could be shown that such crystals as were pyroelectric possessed unilateral conductivity. The principal phenomenon of pyroelectricity was this: that a tourmaline crystal whilst its temperature was being raised became positively electrical at that end called the analogous pole, and negatively electrical at its antilogous pole. The term "unilateral conductivity" had been given by Dr. A. Schuster to a phenomenon of some obscurity, observed by him in certain cases, and which formed the subject of a communication to a former meeting of the Association. The term unilateral conductivity was defined as follows: If the conductivity of a substance in a given direction between two points A and B, was greater (or less) when the flow was in the direction from A to B than when the flow was in the direction from B to A, then such a substance was said to possess unilateral conductivity. Mathematical analysis as yet did not apply to any such case.

It had been argued by the first of the two authors of the paper, that if the tourmaline possessed a unilateral conductivity for electricity it would also be found to possess unilateral conductivity for heat, since the researches of Tait and Kohlrausch had shewn that the two conductivities are comparable in almost all points of analogy. The experimental research therefore had divided into two branches. Delay had taken place from the difficulty of meeting with suitable specimens of tourmaline crystal, and this difficulty was eventually overcome through the kindness of Professor N. Story Maskelyne.

The method first suggested for comparing the two heat-conductivities, as measured in opposite directions along the axis of the crystal, was that of De Senarmont. A slice of the crystal was cut with parallel faces containing the crystallographic axis, and having been covered with wax, or with Meusel's double iodide of copper and mercury was heated from a point by a hot wire. When the experiment was rapidly made, the elliptical isothermal surface marked out by the melted wax or the blackened iodide was found to be displaced from the centre, and this displacement was towards the analogous pole; shewing that whilst the temperature was rising the conductivity in that direction was greater than in the opposite direction. When however the experiment was done slowly with a thicker crystal, so that thermal equilibrium was attained, no such unilateral effect could be observed. Rough preliminary experiments shewed the unequal semi-axes minor to have a ratio of about 10 to 12, but there was considerable discordance in the various results.

A calorimetric method was next adopted to measure the flow of heat across a thin wall of tourmaline cut normally to its crystallographic axis. Steam was applied below one face of the crystal, and the heat which left the upper surface of the crystal was applied to heat a quantity of mercury. Experiments with this apparatus made alternately from opposite faces of the crystal showed that, as before, the conductivity for heat was greater towards the analogous pole, so long as the temperature of the crystal was rising.

In respect of the electrical conductivity, time had only permitted a few preliminary experiments. The slice of crystal was heated in a steam bath; and then a 5 microfarad condenser charged through it by 10 or 12 Daniell's cells was discharged through a sensitive Thomson galvanometer of 7,000 ohms. resistance. The experiment was then repeated with the tourmaline reversed. A very slight but constant difference of conductivity could be detected, but only whilst the temperature was still rising or falling. The principal difficulty lay in the very great resistance of the tourmaline. The authors hoped to be able to continue the investigation using a higher temperature and a far higher electromotive force. They would like to try that of 1,000 cells.

## EDISON'S ELECTRO-MOTOGRAPH.

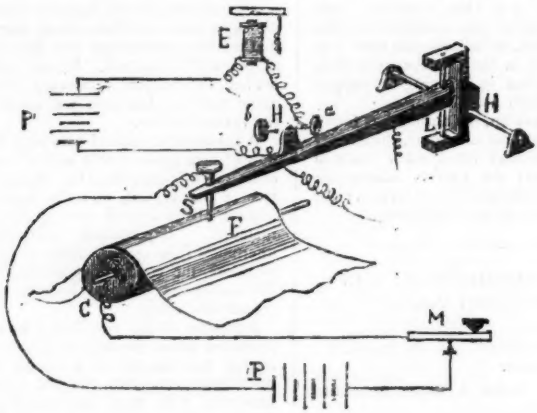
ONE of the most curious instruments exhibited by Mr. Edison—at least, as regards the effects produced by it and the applications of which it is susceptible—is the *electro-motograph*, an instrument devised as far back as 1872, and which has already been used as a telegraphic relay and telephonic receiver.

This instrument enables us to obtain mechanical

effects with an exceedingly small electric force, and upon very long circuits, without the intervention of any electro-magnetic organ. It is based upon the principle that if a sheet of slightly rough paper, steeped in certain solutions, be laid upon a platinised metallic plate, and there be passed over it a strip of sheet metal, preferably lead or thallium, but which may be of platinum, on the passage of a current, a certain slipping of the surface is produced, which makes the friction much less and gives rise to utilisable mechanical effects. Thus by employing as rubber a jointed metal bar held in position by a spring, this bar being dragged onwards by its friction on a travelling paper band, can spring back each time a current passes, and may thus be made to close a local relay circuit. And by adapting this rubber to a sounding box and interposing it in the circuit of a battery telephone, one can obtain from the resonator, vibrations which are the counterpart of the sounds emitted in the telephone. We may in this way have a telephonic receiver without electro magnetic parts, and capable of very great sensibility. The arrangement is, however, principally applicable for musical sounds, although Mr. Adams, Mr. Edison's collaborateur, affirms that speech has been reproduced in this way.

cylinder C, which is in electric communication with the key M, and so with the negative pole of the battery P. L S is a lever pivoting vertically at L on a piece K, which is pivoted horizontally. This lever, furnished at its lower end with a platinum point, and a contact-maker H oscillating between two screws *a*, *b*, constitutes the moveable part of the relay, and is acted upon by two antagonistic springs, one of which R, tends to hold it down upon the paper by means of the points S, the other R', which tends to draw it towards the screw A in the other direction in consequence of the tractile motion of the paper and the rotation of the cylinder C. The screw A is connected with the local circuit of battery P', in which is interposed the electro-magnetic apparatus E, worked by the relay, and the point S is placed in connection with the positive pole of battery P. This point, therefore, by reason of the unequal friction it encounters, constitutes the relay.

Mr. Edison has in this way constructed relays which have worked through a million ohms, a resistance which with the battery employed, was too high for an electro-chemical apparatus with iodide of potassium, and sufficiently high to give no deflection on an ordinary galvanometer. The author remarks that as with this system there are no




The action above referred to may be easily noticed by taking the spring between the fingers, interruptions of the current causing sensible pulsations. The above effects may be produced with a number of substances, but the pole employed varies with them. Thus, when employing potassic hydrate, potassic ferrocyanide, and most of the alkalis, the rubber should be connected with the positive pole, while pyrogallic acid, strontium, nitrate, &c., require the negative. With some substances, however, such as silicate of soda, potassic, hydrate, &c., either pole may be used; and with others, such as sulphate of aniline, the effects described are produced in circuits of high resistance, but not in circuits of low resistance.

The figure shows the electro-motograph arranged as a relay. F represents the strip of sensitised paper, drawn along as in the Morse instrument, and held with a certain tension upon the metal

secondary currents due to reaction of electro-magnets, and as the electro-chemical action is instantaneous, a much greater speed can be attained than with the ordinary systems. The apparatus has, in fact, when used as a translator, transmitted over 650 words per minute, and it could even act on a Morse inker if substituted for the electro-magnet ordinarily employed.

As a telephonic receiver the electro-motograph has the following arrangement. The receiver consists of a resonator and a drum fixed on an axle turned by hand. A strip of paper passes over the drum, the surface of which is rough, and pressing upon the strip is a point similar to S in the figure, but adapted to a spring fixed to the centre of the resonator. The current passes through the spring, platinum point, and chemical paper, and returns by the drum to the battery. When the handle is turned, there results a series of vibrations which

are the reproduction, more or less faithful, of the sounds which affected the transmitter. According to the American journals this instrument can reproduce with great intensity the highest notes of the human voice, notes which can scarcely be distinguished when electro-magnets are employed.

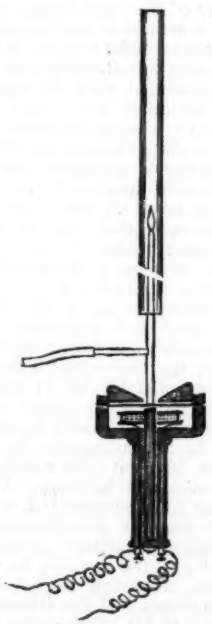
With this telephonic receiver, the transmitter is almost the same as the carbon one of the same inventor, only, instead of the carbon disc, it is a platinum point which is used, and it must not be in continuous contact with the vibrating plate. It is, in fact, analogous to the Riess telephone.

According to Mr. Adams, it is possible to transmit speech with this system when using Edison's carbon transmitter; it is, however, only referred to in the journals as a *musical telephone*.—*L'Electricité*.

## A TELEPHONE ALARM.

By ALFRED CHIDDEY.

THIS arrangement, the invention of the writer, consists of a slender brass tube, eight inches in length, having an orifice of one-twentieth of an inch diameter.



At the upper end this tube is soldered to a telephone diaphragm, as shown in the figure, and a branch serves to connect it with a gas supply through the medium of an india-rubber tube. The jet being ignited at the orifice, the stop-cock is manipulated so that a flame, about half an inch high, is obtained. A glass tube, about 12-in. by $\frac{3}{8}$-in., is then passed over the flame until it commences to sing. The glass tube is now raised about an inch, and the singing stopped by placing the finger, for a moment, on the end. The telephone and glass tube being held in their respective positions, by suitable supports, the arrangement forms the alarm for one end of the circuit. A similar arrangement is adopted for the other end, care being taken that the tubes of both arrangements are similar, so that the notes produced by the two flames may coincide.

If, when the flames are silent, the note of the tubes be sounded near one of them (either by the voice or a tuning fork), then when the flame in that tube starts into vibrations, the latter will be communicated to the diaphragms of the two telephones, and this will set the flame of the second one singing also, and thus give a call signal.

## EDISON'S MEGAPHONE.

FROM the time of the first man until now, men have endeavoured to circumvent nature so as to grasp that which the unaided faculties could never attain. We have telescopes for viewing remote objects, microscopes for making visible the minute, telephones for talking over immense distances, and now, at last, we have a megaphone, which is to the ear almost what the telescope is to the eye, or the telephone to the vocal organs.

The speaking trumpet, which, for two centuries at least, has been employed to direct sound so that it may be heard over a long distance, is much used at sea, and is often employed on land to direct vocal sounds so that they may be heard above other sounds. It is tolerably certain that the speaking trumpet is of modern origin, and that it is the invention of Samuel Moreland, 1670.

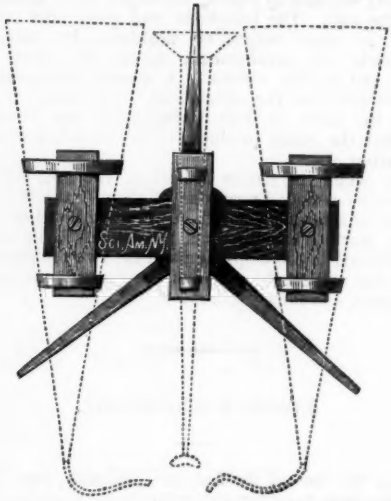
Kircher, in his *Ars Magna et Umbra* and in his *Phonurgia*, mentions a kind of gigantic speaking trumpet, described as the horn of Alexandria. According to Kircher, this horn enabled Alexander the Great to call his soldiers from a distance of ten miles. The diameter of the ring must have been eight feet, and Kircher conjectures that it was mounted on three poles.

Late in the last century Professor Huth, a German, made a model of the horn, and found that it served as a powerful speaking trumpet, but we are considerably in doubt as to the distance through which sounds can be projected through such an instrument.

The ear trumpet, which is the counterpart of the speaking trumpet, has been made in various forms during the last two centuries, but no form yet devised has any advantage over a plain conical tube with a bell-shaped or flaring mouth.

Professor Edison, in his researches on sound, has made many curious experiments, one of the most interesting of which is that of conversing through a distance of 1½ to 2 miles with no other apparatus than a few paper funnels. These funnels constitute the megaphone, an instrument wonderful both for its simplicity and effectiveness. The two larger funnels are

6 feet 8 inches long, and 27½ inches in diameter at the larger end. These funnels are each provided with a flexible ear tube, the end of which is placed in the ear. The speaking trumpet in the middle does not differ materially from the ordinary ones. It is a little longer,




and has a larger bell mouth. With this instrument conversation can be readily carried on through a distance of 1½ to 2 miles. We have conversed and heard singing through the distance named, although both the singing and talking were in the ordinary tone of voice. A low whisper, uttered without using the speaking trumpet, is distinctly audible at a thousand feet, and walking through grass and weeds may be heard at a much greater distance.—*Scientific American.*

## Review.

*Memoir of the late Alfred Smee.* By his DAUGHTER. With a Selection from his Miscellaneous Writings. George Bell and Sons, York Street, Covent Garden. 1878.

THERE is a stage in the life of a man or woman at which the mental gaze, instead of being wholly fixed on the present or the future, is sometimes turned to dwell with interest on the past. It is still a youthful stage, but it is in that advanced youth when earlier youth is so remote as to seem another kind of existence, and the career in the world has been so far won and made manifest that the whole energies are no longer employed in striving and looking forward. There is a similar era, too, in the history of a nation. In America, at the present day, there is evidence of a warm and growing love for the few antiquities which the earlier American colonisation can show. Old mansion houses of the British Governors are surrounded with a halo of historical association; poems and tales without number are written to portray the manners and incidents of the old colonial times; every scrap of information about the poets and heroes of these days is zealously collected; and this worthy enthusiasm was recently carried to so great an excess, as to mistake a weather-worn slab of rock for a runic inscription of the old Norse discoverers. Even so is it in the history of a science. Electricity is one of the youngest of the sciences, yet it is old enough, and settled enough, to begin to feel a real interest in its youth, and in the lives of those of its founders who have passed away. The electric telegraph has risen into existence within the memory of men now living; nevertheless, the men who gave it birth are one by one disappearing from the scene. Their work has been accomplished, and the many who have entered into their labours already turn with reverent eyes toward the story of their lives. The life of Alfred Smee, by his daughter, Mrs. Odling, will be welcome to a number of electricians, to whom the name of Smee is familiar as a household word, and who desire to know something of the character and life-labours of a pioneer in their science, and a contemporary of Faraday, Cooke, Bain, and Wheatstone.

Biographies by female relatives of the deceased, so common at the present time, have their advantages and disadvantages. There is a tendency on the part of a man's widow, or the daughter whom he loved, to magnify each petty detail and peculiarity of his behaviour and achievements to an undue importance; and to sweeten with the honey of their affection, certain personal traits which were a source of gall to all other parties who may have had dealings with him. Long private letters, eminently suggestive of the waste basket, are too often made a source of weariness to the reader, because they happen to excite tender feelings in the memory of the writer; and a partial and biassed view of the whole man is presented with the most charming candour. On the other hand, such biographies generally reveal to us phases of the man's home life—a subject which is always highly interesting, but one which the ordinary biographer would scruple to unveil even if it were always in his power. Everything considered, then, we think that biographies by female relatives, if they may be suspected of giving an imperfect picture of the man, at least furnish valuable supplies of material for a more correct and concise biography in the future.

The most striking feature of the life of Alfred Smee, the accomplished physician, oculist, discoverer, and inventor, was the varied nature of his pursuits. From the beginning to the end of his busy career, he devoted himself to no one subject in particular, and pursued no special road; but, on the contrary, diverged into every by-path that presented itself. As a consequence, he led a good and most useful life; but a life which diffused his energies, and weakened his fame. Wherever he saw an abuse that could be corrected, or a deficiency supplied, Alfred Smee at once undertook the task, and, what is more, invariably succeeded. If he went for a holiday to the sea-side, he was sure to discover that the fishermen needed cheap barometers or storm drums, and the fishermen straightway had them. If his holiday trip were to the Highlands instead, he championed the crofters against the landlords' game. He was either inventing something—a ventilator, a galvanic battery, an optometer, a method of printing bank notes—or

he was fighting the battle of science against the propagation of fever germs in milk and sewage, or in tracing the spread of the potato disease to the ravages of the *aphis vastator*. In 1846, the potato controversy raged to vast proportions, and Mrs. Odling gives the following amusing extract from the Drury Lane Pantomime of that year :—

SCENE.—*A Village Fair, with shows, &c., &c. Little boy looking at a peep-show.*

*Showman.*—This is the *aphis vastator*, as you may see
Very much magnified by Mr. Smee.
*Boy.*—Please, sir, which is the aphis and which is the tater?
*Showman.*—Whichever you like, my young investigator.

Besides his public controversies, his lectures, experiments, and book writing, his occasional letters on lightning strokes and new comets, Smee found time to study politics, as well as attend to his professional duties as physician to the Bank of England, and other societies. But in his contests for the representation of Rochester he was always unsuccessful; the only check to his versatility which he appears to have sustained. All his spare moments were given to the preparation of his large works : *Electro-Biology, Instinct and Reason, The Eye,* the *Mind of Man,* and *My Garden.*

The *Mind of Man* contains his cherished metaphysical system, and is his greatest book.

As a writer he is, of course, gifted with unusual power of thought and fluency of expression; but he too evidently lacks that inborn sense of the beauty and fitness of words—without which no author can be distinguished for style, the touchstone of literary genius.

Smee possessed great powers of abstraction and could compose some of his most abstruse passages while others were conversing in the same room with him; and his power of memory was extraordinary, but capricious. He detested argument, and was intolerant of opposition, his mind seizing its conviction at once. He was impatient of dullness, impetuous, eager and quick to act when his rapid decision was taken; an ardent, restless, active soul, never shrinking responsibility, and full of self-trust. His keen and fervid imagination soaring after new generalisations, fostered a dislike of routine and detail which grew upon him in life and led to carelessness in dress and money matters. Withal his science, there was a high spiritual caste about his mind similar to that which sanctifies the memory of Faraday. His love of nature amounted to a kind of passion; his delight being to cultivate all kinds of flowers and fruit, and make pets of birds, gold fish, or other of our poor relations amenable to discipline. He was fond of London Society too, but only in winter; when summer came he was off to the woods and fields and to his model garden at Wallington, Surrey. He delighted in reading books of *pure* fiction and imagination, such as fairy tales, and poems, a taste not uncommon amongst men of science, who relieve the strain on the noetic faculties by flights of untrammelled fancy. Like Faraday, too, he enjoyed a comedy at the theatre, or a pantomime to his heart's content. Alfred Smee's works show him to have been an essentially religious and benevolent man; but it is pleasant to find that his kindness to the poor took the most humble and unostentatious form. No needy person ever appealed to him in vain, and when the active brain was stilled for ever, and the over-worn frame was laid beneath the turf of Beddington Churchyard, the sobs of the low as well as the high were to be heard around.

Mrs. Odling has told her father's story with much taste and good sense, leaving the selections from his writings to speak for themselves. A very fine engraved portrait by Jeens fronts the title-page, and the book is plainly but neatly bound.

## Notes.

THE TELEPHONE.—The telephone will be fairly tried for military out-post work during the forthcoming autumn manœuvres of the German and French Armies.

MR. ALEXANDER MCNAE writes to *Engineering* to state that by means of a Hughes microphone transmitter, with battery, a telephone, consisting merely of a frame, coil, and vibrating disc, and without any *magnet, or other piece of iron,* will utter speech distinctly, and with moderate loudness.

WE have received from M. Alfred Niaudet a copy of his recent treatise on Telephones and Phonographs. It is a complete and comprehensive little book, printed on toned paper, and beautifully illustrated. It is published by J. Baudry, 15, Rue des Saints-Pères, Paris, We shall have occasion to refer to this work again.

THE MICROPHONE.—Mr. Alfred Chiddey has pointed out in *Nature* that the Microphone acts very well, and in some respects there is less jarring noise heard, when it is placed in a shunt or derived circuit, or the main battery and telephone circuit, *i.e.*, in such a position that when the carbon points are not in contact the whole current will flow through the telephone.

ON another page we give Mr. W. J. Millar's paper to the British Association on his microphonic researches.

THE PHONOGRAPH.—The phonograph experiments of Professors Fleeming Jenkin and J. A. Ewing confirm the theory of Helmholtz, that vowel sounds are made up of harmonic partial tones, and the groups of partials, so far as he gives them, for the vowels we have investigated, agree fairly well with their results. The vowel quality is given by a particular resonator, and the pitch of maximum resonance of the resonator, as stated by Wills and Wheatstone, is an important element in determining the vowel character of the sounds produced.

IN the near future, the bore, instead of carrying an autograph album, will have a phonograph concealed about his person, which he will produce at the unhappy moment, and request his victim to shoot a few words into it to remember him by.—*Oil City Derrick,* U.S.

THE ELECTRIC LIGHT.—At the fashionable watering place of Coney Island, near New York, the electric

light has been put to the novel purpose of illuminating the sands and the sea of Manhattan Beach, in order that bathing might go on during the cool hours of night. Three magneto-electric machines and a steam-engine are employed at the great bathing pavilions, and a light equivalent to that from 3,000 candles is shed over the water, even to a distance of several miles. The spectacular effect of the waves, and the quaint costumes of the bathers, are said to present a strange and weird scene.

TELFORD medals and Telford premiums have been awarded by the Institution of Civil Engineers to Richard William Henry Paget Higgs, L.L.D., Assoc. Inst. C.E., and John Richard Brittle, Assoc. Inst. C.E., for their paper on "Some recent improvements in Dynamo-electric apparatus."

IN the July number of *Poggendorf's Annalen* there is a translation from the works of the Arabain chemist, Abou Moussa Geber ben Hajjan, which describes an experiment proving that the loadstone loses its natural force. Geber flourished in the eighth century of our era.

WE learn from *L'electricite* that the American messenger telegraph will be introduced shortly into France.

THE TELEPHONE.—Count du Moncel thinks that a thick diaphragm in the telephone acts with difficulty because its magnetisation and demagnetisation takes place more slowly, and that a thin diaphragm acts better, not because its smaller mass enables it to vibrate more rapidly, but because it can be magnetised and demagnetised more quickly. The fact elicited by Professor Hughes, that a diaphragm built up of a number of thin plates laid one over the other reproduces the sound in a clearer and louder manner than a single disc, would seem to support this view.

A PLEA recently put by Mr. Elisha Gray before the French Academy of Sciences, to the effect that he was the true inventor of the articulating telephone, and not Professor Bell, was met by the statement that the Academy did not consider it their function to judge the question.

THE MICROPHONE.—Articulate sounds are better reproduced by fine metalised charcoal than by gas coke, while, on the other hand, simple sounds, such as the tick of a watch, are better heard by the latter.

THE possibility of yet being able by means of the microphone to tap the brain of its thought, is a startling idea entertained by Professor Hughes. He reasons that all thought is accompanied by an unconscious action of the articulating organs; we think in words and dream in languages, French when we are living in France, and German when in Germany, and therefore it may come to pass that by a highly sensitive microphone of the future the articulate vibrations of the head will be made audible. Many counter reasons can be urged against this theory; it might be pointed out that the lower animals evidently think without speech at all, that men think when their articulating organs are paralysed or fixed, that articulation is a slow process compared with the flash of thought, that memory and imagination dwell upon scenes without the effort of expression, and that dual thinking is a fact; but, nevertheless, Professor Hughes' notion is an interesting and debatable one. We have learned by the microphone to hearken to the clash of atoms; will it yet be in our power to listen to the working of the brain mechanism and hear the evolution of thought? We doubt.

THE PHONOGRAPH.—In the *Voyages Fantastique de Cyrano de Bergerac* recently republished by the *Librairie des Bibliophiles*, there is a tale entitled, "*Histoire Comique des Etat de la Lune*," which contains an account of a mechanical book which uttered what it had to tell like the phonograph. Cyrano de Bergerac was a kind of Jules Verne who flourished two centuries ago.

THE *Scientific American* for August 24, gives a detailed description with drawings of a simple and inexpensive phonograph which can be made by amateurs. It consists of a straight rod or square of wood run with two parallel V grooves along its face; and a mouthpiece with diaphragm, and spring point, constructed to glide along the rod by means of guides cut in the frame of the mouthpiece in such a position that the probe is over the grooves. A strip of tinfoil is smoothly lapped over the rod and held by bees'-wax. On moving the mouthpiece by hand along the rod and speaking into it the record is taken, and can be similarly reproduced.

THE ELECTRIC LIGHT.—It is stated in the *World* that Mr. Hollingshead attempted to bring Jablochkoff's electric candle to England, before he resorted to M. Lontin, but that Jablochkoff demanded no less than £350,000 for his English patent rights. Mr. Hollingshead did not happen to have that sum handy by him at the time, and so he fell back on the more modest terms of Lontin, whose light is now exhibited nightly at the Gaiety Theatre. Mr. Hollingshead deserves praise for the energy he has shown in establishing the electric light in our midst in spite of many obstacles. The "enterprising impresario" has at last brought out a "star."

THE Australian Intercolonial Telegraph Conference have accepted Col. Glover's terms on behalf of the Eastern Extension Telegraph Company, and a duplicate cable will now be laid between Singapore, Banjoewangie, and Port Darwin. A subsidy not exceeding £32,400 per annum will be payable by the colonies for a period

not exceeding twenty years. These cables will skirt the coast of Java, and thus dispense with the land lines, on which many errors at present occur from the Dutch operators knowing English imperfectly. The new cables will be protected by a complete copper envelope to exclude the marine insects which at present infest the existing cables, and are said to cause the interruptions which have been so prevalent of late.

THE American Chemical Society propose to celebrate the centennial birthdays of Humphry Davy and Gay-Lussac, which occur on the 17th and 6th of December, 1778, respectively.

MR. EDISON has been employed to devise some means of lessening the noise on the elevated railways of New York. These railways are carried along the thoroughfares of the city on iron girders and trestles over the head of the passenger traffic; and what with the clanking of the wheels on the rails, and the humming of the vibrating rods and braces, the din is said to be very disagreeable. The action of the railway company in employing Mr. Edison has been taken under the pressure of a petition signed by a large number of medical men who charge the nuisance in question with producing irritation, hysteria, and even dementia in persons residing within reach of the noise. Mr. Edison has been engaged in analysing the sounds b the phonograph and phonautograph.

EDISON has invented a machine for condensing the noise of the elevated railways in New York, running it down a pipe to the Battery, loading it on the Sound steamboats, and dumping it near Rattleborough, Vt. Great man, that Edison! The Rattleborough people expect to can the noise and sell it for Fourth of July celebrations.—*Phil. Bulletin*, U.S.

WE are glad to learn from the *Journal of the Telegraph*, U.S., that Mr. Frank L. Pope, of the Western Union Telegraph Company, and Mr. C. H. Haskins, Gen. Sup., of the North Western Telegraph Company, have arrived safely in the *Queen*, at New York. These gentlemen express themselves as highly pleased with their reception abroad, and desire our contemporary to return their sincere thanks to those who received and entertained them so kindly, and whose courtesy they will ever hold in pleasant recollection. There is nothing which tends so much to that most desirable thing—a mutually friendly spirit amongst the electricians of Great Britain and America—as these reciprocal visits paid by eminent members of the fraternity. Sometimes we journals of the craft, on both sides of the Atlantic, have occasion to use banter, and even ridicule, but it is done for the sake of piquancy and amusement, or for wholesome correction, and not at all from ill feeling. Any casual freak of that kind is but the play of light on the fretted surface of a stream of deep and cordial good fellowship, which will never fail, we trust, in showing itself to members of our common profession when they come among us personally.

THE American *Popular Science Monthly* for August (D. Appleton and Co., Broadway, New York; London Trübner & Co., Ludgate Hill), contains an interesting article on the Teredo and its depredations in submarine cables. There is also a sketch and excellent portrait of of Mr. T. A. Edison.

THE Continental Telegraph Company, U.S., is expected to begin public business between New York and Philadelphia on or about September 1st.

MDLLE. DODU, a young telegraph operator, who distinguished herself during the Franco-German war by an act of courage and devotion, has been decorated with the Cross of the Legion of Honour. Shut up in a chamber through which the telegraph wires conveying despatches to the German Army passed, she destroyed the connection at the risk of her life.—*The Continental Gazette*.

WE have received from the Director-General of Italian Telegraphs, Rome, a large and finely executed chart of the government telegraph lines in Italy, which has just been published by the Administration.

WE have also received a specimen sheet of the *Ronald's Catalogue*, from Mr. A. J. Frost, librarian to the Society of Telegraph Engineers. This catalogue, which contains more than 12,000 entries, will probably extend to over 600 pages, and is believed to include every important work and almost every paper which has been published upon the subject of electricity and magnetism up to the date of the author's death in 1873. It also forms a valuable catalogue of scientific works generally. Sir Francis Ronalds devoted the greater part of his lifetime to its compilation and in the formation of the valuable library now in the society's possession. The price of the catalogue will be 16s., and for a special librarian's form proposed, printed on one side only, 20s.

WE learn from *Engineering* that a torpedo corps has been formed for New South Wales, under Major Cracknell, the chief electrician of the colony. The torpedos employed by the corps are sunk in the waters of Sydney and connected by submarine cables to the harbour stations.

CAPT. TRERE, of the French Navy, has invented an electric brake by which the speed of a ship's engines may be controlled by touching a button in the cabin or on the quarter deck.

M. COPERG, Director of the French Postal Telegraph Department, proposes to tax each commune receiving weather reports, at the rate of £4 yearly. This step has evoked much discontent and will probably be withdrawn.

ATMOSPHERIC ELECTRICITY AND PLANT LIFE.—According to M. Grandeau, atmospheric electricity is a powerful agent in the process of assimilation amongst vegetables. He says that plants defended from its influence have built up fifty or sixty per cent. less of living (azotic) matter than those exposed to ordinary conditions. The proportion of ash is higher, and that of water lower, in plants sheltered from the action of atmospheric electricity. The electric screen enclosing the plants experimented on was formed of four triangles of iron The plants were maize, tobacco and wheat; all other conditions were the same, but of the two specimens pitted against each other one was screened from atmospheric electricity and the other was not. The plants after being allowed to grow for several months, were then measured, weighed and analysed. All the experiments exemplify the above percentage in the most striking manner. The plants tested are tall, but low growing plants are equally influenced by atmospheric electricity. This fact may help to explain the absence of herbs under certain trees. It should also be mentioned that the total development of the plant is proportional to that of the azotic matter, as in growth, under normal conditions. M. Berthelot, in a subsequent note to the Academy on this subject, draws attention to the discovery made by him that free nitrogen united itself to organic matter under the action of electric currents not only from ordinary induction coils, but from feeble voltaic batteries; for example, five Leclanché cells: the proportion of nitrogen thus fixed in seven months on paper and dextrine being 1·92 thousandths, which will represent about 1·2 hundredths of matter analogous to the nitrogenised compounds of vegetables. It would thus appear that the slow, continuous action of feeble atmospheric currents on vegetation has a far more important bearing on agriculture than the formation of nitrous and nitric acid with their ammoniacal salts by the violence of the lightning flash.

M. GRANDEAU, in a subsequent note to the French Academy, has supplemented the results given in the last note. By aid of a Thomson quadrant electrometer and water-dropping collector, he has measured the electrification under and in the neighbourhood of those large sheltering trees and bushes which appear to impoverish the soil beneath them. He finds that the potential beneath these trees is *nil*, while there is a sensible positive potential beyond the area which their foliage shelters These experiments of M. Grandeau show that it is not want of moisture, light, or heat alone, but want of electricity also, which renders the shade of dense trees so inimical to herbs and undergrowth.

ELECTRICITY AND GARDENING.—Prof. J. Mcagno finds that in grape growing a decrease of the intensity of the available light hinders the formation of sugar; and that the formation of other products of assimilation is directly proportionate to the intensity of the light.

Perhaps the time is not far distant when the electric light will be used for forcing rare fruits and flowers during our dark winters, as much as artificial heat is now.

THE experiments of M. Grandeau described in the above note, also point to a time when the atmosphere of a forcing house may be advantageously charged with electricity as it is now charged with heat. The nature of iron conservatories and vineries tends to act as a screen to atmospheric electricity, and there is, therefore, all the more reason that electricity should be artificially supplied.

A NEW SINGLE FLUID CELL.—Mr. Pulvermacher has invented a novel form of element in which the atmospheric air acts as a depolariser. The exciting liquid (dilute sulphuric acid, caustic potash, or salammoniac) is placed in a porous cylindrical pot. Into this is plunged a rod of amalgamated zinc as a negative pole; while the positive pole is formed of a long curl of fine platinum or silver wire rolled round the pot. The spires of this wire are sufficiently wide apart to avoid capillary action and as they enwrap the pot they come in contact at an infinite number of points with the liquid which exudes from it. It is at all these numerous points of contact that the air exercises its oxidising action and effects depolarisation. The battery can be charged with liquid and discharged again by turning a tap. If zinc and liquid be supplied it will last indefinitely, because the air is always at hand. The electro-motive force of a cell charged with caustic potash solution is about 1½ volts on an average; with pure sulphuric acid diluted with 9 parts of water the electro-motive force is 1·16 volts. With a cell having a silver wire, a porous pot of good quality, 14 centimetres high, and 35 millimetres in diameter, the resistance was only 1·3 ohms. To give some idea of polarisation it should be mentioned that when the circuit was closed by a shunt of 10 ohms during 10 minutes, the electro-motive force diminished about 16 per cent., and it returned to its original value after the circuit had been opened three minutes.

## Correspondence.

*To the Editor of* THE TELEGRAPHIC JOURNAL.

SIR,—In Mr. W. Dennett's paper on "A Single Current Duplex Translator" in the TELEGRAPHIC JOURNAL for 15th July, 1878, the expression "compensation current" is ambiguous. Compensation currents were used in some of the original duplex systems, but I believe they are generally discarded now. The current from battery B divides between the two coils of differential relay E. If the "down" station is sending at the same time the current in the outer coil (connected to line) is neutralised, and consequently the current in the inner coil (joined to rheostat) preponderates and therefore actuates the relay tongue.

In the sketch I observe that the copper pole of battery A, and the zinc pole of battery B, are connected to earth. I think the zinc poles of both batteries

should be to earth. If not, perhaps Mr. Dennett will kindly explain why.

The second relay, or automatic key, appears to me unnecessary, as the sounder can be made to answer the same purpose by placing it directly between the tongue and the working contact of the differential relay, connecting armature of sounder to terminal B, and the standard on which it falls, when attracted, to terminal F of the switch.

In single working battery A is used for "down" and battery B for "up" line, but in translation, battery B is used for "down" line. Unless the resistance of the two sections is the same the battery must be unsuitable in one case.

By joining permanently terminal B of one switch to terminal C of the other, and removing the connection between terminals B and C of each switch, the proper battery power for translation would be obtained.

I am, sir,

Yours truly,

H. A. W. FANSHAWE,

September 2nd, 1878. Indian Telegraphs.

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*To the Editor of* THE TELEGRAPHIC JOURNAL.

SIR,—In your issue of July 1st, 1878, in commenting on the claims of Professor Thomson and myself to the invention of the Telephone Relay, as contained in a short note to *Nature*, of June 20th, you remark that the application of the microphone to this purpose was pointed out by Professor Hughes at the meeting of the Physical Society, on June 17th. Your writer could scarcely have noticed that the note in *Nature*, on which his remarks were based, was dated Philadelphia, June 7th, as that date would clearly anticipate the application suggested by Professor Hughes.

Professor Thomson and myself exhibited a successful working model of an invention, at the Franklin Institute and elsewhere, on June 4th, accounts of which were published in the papers of this city on the following day.

Respectfully yours.

EDWIN J. HOUSTON.

Central High School,
Philadelphia, August 22nd, 1878.

[In our note of July 1st we had no intention to deprive Professors Houston and Thomson of the merit of this application, but merely to point out that such an application had been already suggested in England. Even if these gentlemen had not actually done the thing before Professor Hughes suggested it, the credit of performance would still have been theirs.—Ed. T. J.]

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*To the Editor of* THE TELEGRAPHIC JOURNAL.

DEAR SIR,—In your issue of 1st inst., I notice Professor Hughes has employed the microphone to settle the controversy between Colonel Navez of Belgium, and Count du Moncel, respecting the explanation of the physical action of the articulating telephone.

Having had perhaps as many facilities for experimenting in this direction, and those experiments having had their origin in the years 1869 and 1870; and having been continued up to the present time, it may be interesting to your readers to know that I have arrived at precisely similar conclusions to Professor Hughes in respect to the production of sound in the magnetised core. These conclusions had, in the first instance, been derived from experiments with alternating currents from a secondary coil, the make and break being a tuning fork similar to those employed by my brother Cromwell in his Harmonic Telegraph, patented in 1870.

Using then these currents, almost all descriptions of rheotomes will produce harmonic sounds, some feeble, others more intense; of the feeble class may be placed first the iron rod surrounded by a coil similar to Riess's receiver.

The second form is that of an iron hollow cone or funnel, in the spout of which is placed a bar magnet, the wire or coil being wrapped on the outside.

The third is an iron tube placed in a coil, in which is inserted the poles of two bar magnets, the north and south poles approaching to within an inch, so that the central part of the hollow core is highly magnetised.

This latter form gives articulate sound from a microphone sender. It may be urged that in the experiment described by Prof. Hughes the bar magnet resting on the top of the coil shown in fig. 1, page 361 (TELEGRAPHIC JOURNAL), is, after all, a modification of the vibratory plate of the Bell telephone, that the alternation in the current flowing through the coil would set the bar in vibration, and those vibrations being communicated to the resonating sounding board, become augmented and easily audible. But it will be seen that the hollow iron tube is free from this objection. The sound being produced between (if I may use the term) the current flowing through the coil and the magnetism in the core, so that when the relations between them are disturbed a sonorous vibration is the result.

I have succeeded in constructing a receiver which depends entirely on the magnetised core as the source of power, independently of the vibratory plate used in the Bell telephone. It gives very clear sounds, and will answer to either the currents conveyed by the microphone sender or from a Bell telephone. These results I hope to be able to make the subject of a communication to one of the societies, where diagrams and experiments will explain more clearly the methods employed and the results obtained than I can possibly do by this letter. I have likewise been examining the action of the microphone, and shortly I shall give details of experiments which will subvert Prof. Hughes' theory of molecular contact and vibration as clearly as his experiments have assisted the labours of the Count du Moncel, who has helped considerably in throwing much light on this, at present, imperfectly known action of the articulate telephone.

I am, dear Sir, yours very truly,

FREDK. H. VARLEY.

Sept. 10, 1878.

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J. J. FAHIE.—Many thanks for your letter. Your suggestions are good, and we will certainly bear them in mind. No. 125, TELEGRAPHIC JOURNAL we sent as you requested.

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## THE ELECTRIC LIGHT AT SEA.

The following interesting letter has been received by Messrs. Siemens Brothers:—

S.S. "Faraday,"
London, August 11th, 1878.

DEAR SIRS,—During our last voyage homeward from New York, we had a proof of the utility of the electric light on board ship.

On the night of the 18th July, near the Georges Bank, we narrowly escaped collision with a large full-rigged ship, under the following circumstances:—

About 10.30 p.m., wind fresh from westward, fog very dense. Suddenly we heard the sound of a bell ringing furiously, at a short distance nearly ahead. We immediately stopped our engines, and, supposing it to be a fisherman at anchor or almost stationary, I ordered the wheel to be ported; at the same moment the electric light pierced the fog, and plainly showed the head sails of a ship heading to the southward and crossing the bow. Not a moment to be lost, we shifted the wheel to starboard, put the port engines full speed astern, and starboard engines full speed ahead, and cleared her by

a few feet only. Our look-out men say they could have stepped on her stern.

She appeared to be full of passengers, and the cries of women and children were heartrending. I never shall forget it. I hailed them several times, telling them they were safe; but it was no easy matter to get them to realise it, seeing death, as it were, staring them in the face.

Of course they could see nothing but our powerful light, whereas we could plainly see people and everything on board the other ship. Had I not been able to see her so plainly, and the way she was going, we must have gone over her, or she might have struck us on the port bow: in either case the loss of life must have been great, and even now it seems terrible to contemplate.

In this particular case we are more than a thousand times compensated for the trouble and expense in fitting our electric light, and I wish all other steamship owners would adopt it as a means of safety in navigation: for, I believe, when the reflectors are properly adjusted, that the land as well as ships may be seen on a dark night in time to avoid danger.

I am, dear Sirs,
Yours faithfully,
(Signed) SAM. TROTT.

## General Science Columns.

RESULTS OF THE SOLAR ECLIPSE.—The most striking fact about the recent solar eclipse was the greatly diminished brightness of the corona as compared with the eclipse of 1871. That eclipse took place during one of the sunspot periods, or times of great solar activity, accompanied by a large red corona, many spots and prominences, magnetic storms, auroræ, and earth currents, as well as heavy rainfall and freedom from famines. This present year there are few or no spots, the prominences are much rarer, the magnets are undisturbed, there are no aurora, and it may also be noted that there are no famines. This year also the corona is small and white. In 1871 the continuous spectrum of the corona contained a great number of brighter lines, caused by irruptions of glowing gas bursting into the sun's upper atmosphere, and indicating an intense energy of heat. This year those bright lines are absent, showing that the solar energy is lessened; a fact borne out by the decrease of solar radiation to the earth this year. The continuous spectrum, which is due to solid or liquid bodies, shows by its want of bright lines that the cooler envelope has settled down closer on the sun and that there is waning of its internal energy. These solid and liquid particles are supposed to be meteoric bodies. According to one measurement, the cromosphere was found to be 2,000 miles in thickness. The upper and lower portions of the sun were graced by exquisite tracery, bending over right and left like plumes of ostrich feathers, the intervals between being of a delicate blue. The structure of the corona was distinctly less filamental than before. Prof. Cleveland Abbe, prostrated by weakness at a point midway up Pikes' Peak, had the rare fortune to note, with the naked eye, the singular appearances of the streamers, which are a luminous haze, extending far beyond the corona. As seen by some, it resembled a wind vane in shape, the black disc of the sun occupying its middle and the three corners projecting beyond, its general direction being that of the ecliptic. Prof. Abbe likened it to two triangles crossed at right angles with the moon's disc, in the middle region common to both; thus giving streamers nearly at right angles to the ecliptic, a result totally unexpected but now beyond doubt. Prof. Abbe attributes these streamers, which extend to five or six solar diameters from the sun, to meteor streams, while Prof. Newcome regards this matter as causing the zodiacal light.

The dark lines observed in the coronal spectrum and the evidence of polarisation of the sun's light received, endorse the belief that the coronal light is due partly to true solar light reflected to us by the molecules of corona, as it reaches them. Professor Hastings declares the polarisation to be tangential, a result which can only be explained according to our present knowledge, on the amusing supposition of *ice crystals in the sun's atmosphere.*

Professors Watson and Swift have signalled an intra-mercurial planet which may turn out to be the suspected Vulcan planet of Leverrier.

The black shadow of the moon, its rim fringed by a coloured iris or spectrum, as seen from the summit of Pikes Peak, cleaving its way along the lower air was a most striking sight, and appeared solid enough to sweep everything before it. On the wide expanse of the Alkali Plains round Separation and Preston—plains broken by no object save the wonderful avenue of telegraph poles along the railway, and the solitary water tank and telegraph operator's house, all was clad in a weird and leaden light. The fall of temperature during the eclipse at some of the most southerly stations was about 20° Fah. Edison's tasimeter showed distinctly the passage of the slit of the telescope to which it was attached from the dark disc of the moon to the image of the corona. Not giving quantitative results, however, it was of no service, and Professor Young resorted to a thermo-electric pile, with which he discovered a heat line in the ultra red, a result which opens out another new field for future eclipses. On the whole the last eclipse has been a most successful one, and not the least of its success is the eagerness to which it has given rise among astronomers to behold the next.

A NEW METAL.—M. Lawrence Smith announced the discovery of a new metal, which he has called "Mosandrum." It is found in the mosandria earth, a mineral belonging to the gadolinite family, and is analogous in its properties to cerium and terbium. This "new" metal has since been proved to be terbium.

ARTICULATION.—We make the following quotation from an exhaustive and excellent paper on "Speaking Machines," in *Good Words* for July:—"Articulate sounds we all know can be separated into two elements, vowels

and consonants, the former being the groundwork of the latter, or, as Max Müller remarks, 'consonants fall under the category of noises,' due to the working of the mechanism producing them. The pure vowels are produced by a continuous expiration, the mouth being kept open, but the size of its cavity varied by altering the position of the lips and palate. The vibration of the vocal chords yield an indiscriminate mixture of sounds—a compound tone; the mouth forms a resonant chamber, like a cave; and by adjusting the size of this chamber certain elements of the compound tone are strengthened to the exclusion of the rest; just as the sound of a Jew's harp, when held between the teeth, is intensified by the resonance of the mouth, and modified by the size we permit our tongue to give the cavity. These changes can be recognised if we pronounce successively *e* (as in he), *a* (as in hay), *o* (as in oh), *oo* (as in cool).

"The theory of vowel sounds was first enunciated by Wheatstone, and confirmed by the experiments of Donders, whilst the classical researches of Helmholtz, leave but little doubt as to the origin of these sounds. Helmholtz, in fact, has not only dissected the vowel sounds, and discovered their constituent elementary tones, but he has put together these elementary tones yielded by different tuning forks, and so built up the entire series of vowels by mechanical means.

"Certain consonants, as *h*, *s*, *l*, *r*, &c., may also be produced by continuous currents of air, modified by the tongue and lips. Other consonants, such as *m* and *n*, or *b* and *p*, &c., can only be produced by momentarily stopping the current of air, and commencing or finishing the vowels by a kind of explosion, thus, *ba*, *at*, *me*, &c.

"It is possible to make a rough imitation of the larynx by simply rolling a sheet of foolscap into a narrow tube, and over one end, tying side by side, a couple of strips of thin india-rubber; on blowing through the tube a musical note is obtained, which can be varied in pitch by squeezing the tube, and so altering the tension of the india-rubber vocal cords. Nay, more, when speech has been lost by disease or removal of the natural vocal chords, artificial ones, formed of a vibrating tongue, or 'reed' of metal or ivory, have been made, and inserted in the larynx of the sufferer, restoring to him at once the power of speech. In fact, so successful is this artificial substitute, that the only difference noticeable, appears to be the peculiar monotone of the speaker; who, however, has the advantage of having a variety of voices at command, for by selecting a grave 'reed,' to-day, he can roar like Bottom, the weaver, and by using a high pitch to-morrow, speak with the shrillness of a shrew."

TURKEY in Asia embracing within itself the temperature of every climate, and enjoying a fertile soil, is capable of producing the products of every climate. As it is, cereals of every kind are found in abundance. Cotton, where cultivated, has proved very successful. Silk is furnished with facility in an extensive region starting from Diarbekir and going down to the Black Sea. Opium, rice, gall nuts, many varieties of dyeing woods, and many other products of agriculture are cultivated in quantities which more than meet the demands of commerce as it exists, and yet not one quarter of the land capable of producing is under cultivation. Extensive forests of oak, pine, beech, ash, cedar, walnut, and chestnut now grow but to rot away. The mineral wealth of the land is, so to speak, untouched, though known to be abundant. The only metal extracted from the earth is copper; yet lead, silver, iron, coal, and mercury are known to exist in abundance. It can be truly said of Asiatic Turkey that its impoverished population treads in its misery on gold.

CYPRUS.—The vines are richer than in any other country, and, when properly cultivated, will supply us with the wine Homer praised so much. Throughout Turkey in Europe it is used as a cure for consumption, and the Americans have of late been drawing large supplies of it. Aromatic tobacco of the most delicate quality is extensively grown, principally for the St. Petersburg market. Fine hard timber is plentiful, notwithstanding the enormous quantities that have been recklessly cut down by the Government, and a Turin firm are now exhibiting some rare specimens in Paris; sleepers for railway and other purposes will be found in abundance, especially when the existing roads are repaired and others constructed; rice, beans, wheat, barley, olives, raisins, locust-beans, cotton, hemp, wool, silk, beeswax, honey, madder, and beet-root are extensively exported. The mines are rich in copper, and a proof of gold existing is that large pieces of the precious metal are daily washed down by the mountain streams; capitalists will find the mines, once worked by the Greeks and others, but now abandoned, a source of unlimited wealth. Coal is also found, but, through lack of enterprize, the mines have never been touched; mineral and lake salt is abundant, and ozokerit exists not far from Leucosia, also at Citti.

DREDGING IN THE GULF OF MEXICO.—We are indebted to *Nature* for the following facts, derived from the dredging operations of the U.S. steamer *Blake*, in the Mexican Gulf, between Yacatan and Florida. The great Alacran reef is an atol—an atol existing, not as Darwin suggests to be the case with atols in general, in an area of depression, but in one of elevation, like those in which the Florida and Bahamas reefs are found. The formation of the Alacran reef is in full activity. The eastern slope is nearly perpendicular, rising to a height of twenty fathoms from the surface, in a comparatively short distance. It is exposed to the full force of the north east trades, and the surf breaks heavily against the great masses of *Madrepora palmata*, which build up the narrow line of coral barely flush with the level of the sea. Along the Cuban coast the dredge

brought up immense numbers of silicious sponges, a species of Favosites, which is perhaps the most interesting coral ever dredged. Amongst the strange fish brought up by the dredge, which worked well to a depth of 2,000 fathoms, there was a huge tadpole, with a gigantic round cartilaginous head, and without eyes; and of another with a drawn-out, flat head, very little eyes, but possessed of gigantic filaments, as long as the whole body. A steel galvanised wire and hemp rope 1¼ inch in circumference, was used with the dredge, It weighed 1 lb. to the fathom, had a breaking strain of over 8,600 lbs., and sank by its own weight. The time required to reel in was always under a minute per 100 fathoms, while the time required to sink averaged 35 to 45 seconds per 100 fathoms in the deepest soundings.

## City Notes.

Old Broad Street, September 13, 1878.

The report of the Directors of the Direct Spanish Telegraph Company for the half-year ending 30th June last, state, that owing to the continued depression in the Spanish trade, the net profits for that period amount to only £3,411 16s. 8d. The dividend on the preference shares, payable on October 1st, will absorb £2,921 10s., and leave a sum of £490 6s. 8d., which, with a small further amount, would be sufficient to pay the arrears of 1s. 9d. per share still outstanding on the preference shares. The directors recommend the withdrawal of this further amount (£20 18s. 7d.) from the reserve fund. The reserve fund at present stands at only £1,097 9s. 4d. Hopeful signs of a revival of business with Spain are mentioned, they being particularly noticeable in the iron districts around Bilbao, where greater activity, it is said, prevails than has been the case for several years past. Sincerely we hope the Direct Spanish Telegraph Company may have a more successful time before it. The cables of the company, the report states, are in the same high electrical condition as at the time of the last report.

Since our last issue the Eastern Extension Company have notified the temporary interruption of their Singapore-Batavia Cable for repairs; communication has now been re-established.

The Amoy-Shanghai Cable has also been interrupted and restored.

Mr. Abbott in his last monthly list says nothing respecting telegraph property; he, however, refers to the recent depression in gas shares owing to the interest now being manifested in the electric light, and remarks that "it cannot be ignored that there is at last a slow awakening to the fact that we are on the eve of a great revolution in the lighting of our cities and towns."

The following are the late quotations of telegraphs:—Anglo-American, Limited, 60¾-61½; Ditto, Preferred, 90-91; Ditto, Deferred, 34-34¼; Black Sea, Limited, 2-3; Brazilian Submarine, Limited, 6⅞-6¾; Cuba, Limited, 9½-10; Cuba, Limited, 10 per cent. Preference, 15¾-16½; Direct Spanish, Limited, 1¾-2½; Direct Spanish, 10 per cent. Preference, 9½-10; Direct United States Cable, Limited, 1877, 13-13½; Eastern, Limited, 7½-7⅝; Eastern, 6 per cent. Debentures repayable October 1883, 106-109; Eastern 5 per cent. Debentures repayable August, 1887, 99-101; Eastern 6 per cent. Preference, 11½-11¾; Eastern Extension, Australasian and China, Limited, 7⅜-7⅝; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 106-108; German Union Telegraph and Trust, 8-8½; Globe Telegraph and Trust, Limited, 5½-5⅝; Globe 6 per cent. Preference, 10⅞-11½; Great Northern, 8-8¼; Indo-European, Limited, 20½-21½; Mediterranean Extension, Limited, 3-3½; Mediterranean Extension, 8 per cent. Preference, 9½-10; Reuter's Limited, 10-11; Submarine, 217-222; Submarine Scrip, 2-2½; West India and Panama, Limited, 2-2½; Ditto, 6 per cent. First Preference, 8½-9; Ditto, ditto, Second Preference, 8¼-8¾; Western and Brazilian, Limited, 3¾-4½; Ditto, 6 per cent. Debentures "A," 93-96, Ditto, ditto, ditto, "B," 91-93; Western Union of U. S. 7 per cent, 1 Mortgage (Building) Bonds; 114-118; Ditto, 6 per cent. Sterling Bonds, 102-104; Telegraph Construction and Maintenance, Limited, 30½-31; Ditto, 6 per cent. Bonds, 100-103; Ditto, Second Bonus Trust Certificates, 2⅜-2⅝; India-Rubber and Gutta-Percha and Telegraph Works, Limited 30-31.

## TRAFFIC RECEIPTS.

| Name of Co., with amount of issued capital, exclusive of preference and debenture stocks. | Anglo-American Co. £7,000,000. | Brazilian Sub. Co. £1,300,000. | Cuba Sub. Co. £160,000. | Direct Spanish Co. £116,379. | Direct U.S. Co. £1,102,420. | Eastern Co. £3,697,000. | Eastern Ex. Co. £1,997,500. | Gt. Northern Co. £1,500,000. | Indo-Euro. Co. £425,000. | Submarine Co. £338,225. | West Coast America Co. £300,000. | Western and Brazilian Co. £1,398,200 | West India Co. £883,410. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | £ | £ | £ * | £ | £ | £ | £ | £ | £ | £ ‡ | £ | £ b | £ * |
| August, 1878 ... | 43,720 | 11,244 | 2,700 † | 878 | 14,560 | 35,889 | 24,870 | 18,413 | ... ... | 10,151 | ... ... | ... ... | 4,336 |
| August, 1877 ... | 41,170 | 9,513 | 2,729 | 790 | 15,700 | 40,428 | 25,371 | 17,998 | ... ... | 9,683 | 2,025 | 7,790 | 4,200 |
| Increase ... ... | 2,550 | 1,731 | ... ... | 88 | ... ... | ... ... | ... ... | 415 | ... ... | 468 | ... ... | ... ... | 136 |
| Decrease ... ... | ... ... | ... ... | 29 | ... | 1,140 | 4,539 | 501 | ... ... | ... ... | ... ... | ... ... | ... ... | ... ... |

* Estimated. † June Traffics realised £3,277. ‡ July Traffics were £2,250. b Not published.

*(The figures in this Table are as accurate as it is in our power to make them, but we do not guarantee their correctness).*